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Effect of Pre-sowing Treatment and Sowing Time on Germination and Early Performance of *Melia composita*

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Abstract: The pre-sowing treatments (soaking drupes in gibberellic acid 50 ppm for 24 hours, soaking drupes in gibberellic acid 100 ppm for 24 hours, soaking drupes in concentrated H_2S0_4 for 10 minutes, soaking drupes in concentrated H_2S0_4 for 15 minutes, mechanical scarification-cracking of drupes, soaking drupes in cow dung slurry for 30 days and control-no treatment) were tested to enhance the germination of *Melia composita* at two sowing time (20th April and 04th May). Germination and most of the growth parameters were recorded highest in mechanical scarification. The sowing of 20th April had significantly higher collar diameter, number of leaves, fresh shoot weight, dry shoot weight, length of primary root, number of secondary roots, fresh root weight, dry root weight, total seedling fresh weight, total seedling dry weight and seedling quality index than the sowing date of 04th May. The interaction of mechanical scarification x sowing-20th April also had significantly higher values for the most studied growth parameters than the remaining interactions. The study implies that mechanical scarification of drupes of *Melia composita* and sowing in the month of April is appropriate for obtaining good quality planting stock.

Keywords: Seed, Germination, Seedling, Growth, *Melia composita*

Forests and trees play an important role in people's livelihoods and provide products such as food, fodder, fuel, timber and many other non-timber products in addition to indirect services in the form of contribution to maintenance of ecological balance and nutrient cycling. Forests have now gained importance for their role in storing and recycling the earth's carbon through photosynthesis (Schroeder 1994). Forests also play an important role in conservation of biodiversity (FAO 2020) and they have a key role in alleviating poverty and improving food security (FAO 2003). Forests and trees also make an indirect contribution to food security by helping to maintain the environmental conditions suitable for agricultural production (FAO 2020). There are about 1.6 billion people in the world who rely heavily on the forest resource use for their livelihoods. For the world's poor, trees and forests are a vital part of everyday survival and provide 2.4 billion people with fuel to cook (FAO 2020). Deforestation and forest degradation is continuing at a very faster rate, which have adverse affects on the direct and indirect benefits being derived from the forests.

A plantation of trees is one of the solutions to increase the tree cover. At present, forest plantations and agroforestry farms in many countries are dominated by few species like Eucalyptus, Poplar and *Casuarina* spp. as major sources of raw materials for pulp and paper. However, these species are now being constrained by poor productivity, pests and diseases and are causing ecological degradation. So, there is an urgent need to diversify forest plantations, which is now dominated by few exotics. To address these concerns, there is a need to explore new potential of tree species, which are fast growing and adapted to wide agro-climatic conditions as alternate sources of tree products and raw materials for pulp and paper. *Melia composita* is one of such species. The species has been reported to have null allelopathic effect on under storey crops (Kumar et al. 2017, Parmar et al 2018), hence could be a promising species for on-farm and off-farm plantations. Wood of *Melia composita* is an excellent and highly suitable raw material for wood based industries like paper and plywood industries owing to its natural anti-termite property, high pulp recovery and exceptional fibre strength as compared to traditional raw material (Sarvannan et al. 2013). The species performs exceedingly well attaining the harvestable size within 6-8 years and has a ready and assured market due to its multipurpose utilities. Poor germination is a hurdle in afforestation of this species. Therefore, there is a need to enhance its germination capacity and growth by suitably treating its seed (drupes) to obtain quality planting stock for afforestation programmes. Hence, study was conducted to record the performance of pre-sowing treatment and sowing time on germination and early growth of *Melia composita*.

MATERIAL AND METHODS

The present study was conducted at the experimental farm of the Division of Agroforestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-Jammu), India during the period from April 2019 to November 2019. The experimental site is situated in subtropical, Jammu region of Union Territory of Jammu and Kashmir which is located at an altitude 332m above mean sea level with 32° 40′ N latitude and 74° 58′ E longitude. Jammu being a subtropical region experiences hot dry summers, humid rainy season and cold winter months. The summer season usually starts from April and lasts up to June. The maximum temperature rises upto 45°C during May to June and minimum falls to 1°C during winter. The average annual rainfall ranges from 1000-1200 mm with 75-80% of which is received during July to September and rest 20-25% during winter months of December to February.

Seed collection and experimental design: Drupes for carrying out the experiment were collected from the four year old plantation in February, 2019. The drupes were dried in shade for about a month and different pre-treatment were given to the drupes. The sowing of pre-treated drupes was done on 20^{th} April and 04^{th} May (2019). Light irrigation was applied immediately after each sowing followed by weeding and watering as per requirement till the end of the experiment. The experiment was laid out in Factorial CRD (Complete Randomization Design) having two factors i.e. seven pre-sowing treatments (soaking drupes in gibberellic acid 50 ppm for 24 hours, soaking drupes in gibberellic acid 100 ppm for 24 hours, soaking drupes in concentrated H_2S0_4 for 10 minutes, soaking drupes in concentrated H_2S0_4 for 15 minutes, mechanical scarification-cracking of drupes, soaking drupes in cow dung slurry for 30 days and control-no treatment) and two above mentioned dates. There were 10 polybags (size 16 cm x 24 cm filled with sieved soil, sand and FYM in ratio of 1:1:1) per replication per treatment. For recording data, two plants per treatment per replication were chosen using simple random sampling with replacement method. In this way a total of forty two plants were chosen for data recording. The observations on germination, collar diameter (mm), seedling height (cm), number of leaves, length of primary root (cm), number of secondary roots, fresh shoot weight (g), dry shoot weight (g), fresh root weight (g), dry root weight (g), total seedling fresh weight (g), total seedling dry weight (g), root: shoot ratio (dry weight basis), seedling quality index and sturdiness quotient were recorded in the month of November 30, 2019. The final seed germination was recorded 72 days after sowing when no further germination took place. The shoots and roots of sampled plants were dried in hot air oven at 65°C for 48 hours to obtain respective dry weights. After drying, the shoot and root weights of each sampled seedling were recorded using digital electronic balance. Sturdiness quotient was calculated by using the formula given by Rollar (1977) and Seedling quality index was estimated by using the formula given by (Dickson et al 1960). The data was analyzed using the technique of analysis of variance (ANOVA) in accordance with procedure outlined by Gomez and Gomez (1984). The effect of different treatments was tested at 0.05 level of significance.

RESULTS AND DISCUSSION

Germination: The pre-sowing treatments significantly affected drupe germination (Table 1). The maximum germination (46.68%) per cent was observed in mechanical scarification, which was statistically at par with treatments of soaking drupes in GA_3 100 ppm for 24 hours and soaking drupes in GA_3 50 ppm for 24 hours but significantly higher than the remaining treatments. The minimum germination (20%) was observed in the cowdung treatment and control (Table 1). The effect of date of sowing on germination was also significant (Table 1). The germination obtained in sowing of 04^{th} May (50.48%) was significantly higher than that of 20^{th} April (14.76%). The interaction of treatment x sowing date exhibited non-significant influence on seed germination (Table 1).

Aboveground parameters: All the aboveground parameters (seedling height, collar diameter, number of leaves, fresh and dry weight) of the seedlings were significantly influenced by the pre-sowing treatment of the drupes (Table 2). The maximum seedling height (163.18 cm), collar diameter (12.96 mm), number of leaves (24.72), fresh shoot weight (229.66 g) and dry shoot weight (75.80 g) was observed in mechanical scarification, which were statistically superior to the respective values in the remaining treatments (Table 2) but collar diameter in mechanical scarification was statistically at par with soaking drupes in concentrated H_2SO_4 for 15 minutes but significantly superior to the remaining treatments (Table 2). The number of leaves in mechanical scarification was statistically at par with soaking drupes in GA_3 50 ppm for 24 hours, soaking drupes in concentrated H_2SO_4 for 15 minutes and soaking of drupes in H_2SO_4 for 10 minutes (Table 2).

The interaction effect of pre-sowing treatment x sowing date was also significant with to respect to all the studied aboveground parameters (Table 2). The interaction mechanical scarification x 20^{th} April resulted in maximum seedling height (239.43 cm), collar diameter (20.90 mm), fresh shoot weight (345.00 g) and dry shoot weight (113.86 g) which were statistically superior to all the remaining interactions. The interaction mechanical scarification x 20^{th} April also resulted in maximum number of leaves (35.37) but this was statistically at par with interaction soaking drupes in H_2SO_4 for 15 minutes x 20th April but superior to the remaining interactions.

Belowground parameters: The maximum length of primary root (26.17 cm), number of secondary roots (20.80), fresh root weight (80.37 g) and dry root weight (22.70 g) were recorded in mechanical scarification, which was statistically higher than respective values in the remaining treatments (Table 3). The lowest root length (7.35 cm), number of secondary roots (8.67), fresh root weight (38.77 g) and dry root weight (10.41g) was recorded in control. The length of primary root (19.60 cm), number of secondary roots (13.71), fresh root weight of (74.86 g) and dry root weight (17.50 g) was significantly higher in sowing of 20th April than respective values of 04th May (Table 3).

The interaction of pre-sowing treatment x sowing date also significantly affected all the above ground parameters of the seedlings (Table 3). The interaction mechanical scarification x 20th April had the maximum number of secondary roots (26.00), fresh root weight (131.50 g) and root weight (35.20g) which were statistically superior to the remaining interactions. The interaction mechanical scarification x 20th April also resulted in longest primary root (30.23 cm) but was statistically at par with mechanical scarification x 20th April but superior to remaining interations (Table 3).

The pre-sowing treatment response on seedling parameters was also the same. All the parameters (except root: shoot ratio and sturdiness quotient) were highest in treatment mechanical scarification. Most of these parameters (seedling height, fresh shoot weight, dry shoot weight, length of primary root, number of secondary roots, fresh root weight, dry root weight, total seedling fresh weight and total seedling dry weight) were statistically superior in mechanical scarification in comparison to remaining all the pre-sowing treatments. The germination per cent in mechanical scarification was highest but it was statistically at par with soaking of drupes in GA_3 100 ppm for 24 hours and soaking of drupes in GA_3 50 ppm for 24 hours. Highest collar diameter was observed in mechanical scarification but it was at par with that of soaking drupes in H_2SO_4 for 15 minutes. In treatment mechanical scarification, the number of leaves was highest but at par with soaking of drupes in GA_3 50 ppm for 24 hours, soaking drupes in H_2SO_4 for 15 minutes and soaking drupes in H_2SO_4 for 15 minutes. Similarly seedling quality index in mechanical scarification was observed to be highest but at par with cowdung. Luna et al. (2014) also described mechanical scarification as one of the effective pre-sowing treatments to break physical dormancy caused by hard seed coat.

Mechanical scarification was found to be most effective

Table 1. Effect of pre-sowing treatment and sowing date on germination percentage*

Treatment	Sowing date		Mean
	20th April	4th May	
Soaking drupes in GA_3 50 ppm for 24 hrs	10.00 (18.43)	63.33 (53.13)	36.67 (35.78)
Soaking of drupes in GA_3 100 ppm for 24 hrs	26.66 (30.98)	66.67 (55.05)	46.67 (43.02)
Soaking of drupes in conc. H_2SO_4 for 10 minutes	10.00 (18.43)	40.00 (38.83)	25.00 (28.63)
Soaking drupes in conc. H_2SO_4 for 15 minutes	16.67 (23.35)	43.00 (41.05)	30.00 (32.20)
Mechanical scarification	20.00 (26.06)	73.33 (58.98)	46.68 (43.52)
Cowdung	10.00 (18.43)	30.00 (33.19)	20.00 (25.81)
Control- no treatment	10.00 (18.43)	36.67 (37.13)	23.33 (27.77)
Mean	14.76 (22.02)	50.48 (45.34)	
Effect		CD (p=0.05)	±SE(m)
Treatment		12.77 (7.99)	4.41 (2.76)
Sowing date		6.83 (4.27)	2.36 (1.47)
Treatment x Sowing date		N.S -	6.24 (3.90)

*Figures in parenthesis are transformed (angular) values

Table 2. Effect of pre-sowing treatment and sowing date on aboveground parameters

Treatment	Parameter	Sowing date 20th April	Sowing date 4th May	Mean
Soaking drupes in GA_3 50 ppm for 24 hrs	SH	43.33	138.17	90.75
	CD	8.02	7.37	7.69
	NL	28.33	20.83	24.58
	FSW	128.43	150.77	139.60
	DSW	37.50	39.20	38.35
Soaking of drupes in GA_3 100 ppm for 24 hrs	SH	85.57	121.27	103.42
	CD	8.63	6.90	7.77
	NL	20.20	19.93	20.07
	FSW	144.13	151.38	147.75
	DSW	34.16	37.85	36.00
Soaking of drupes in conc. H_2SO_4 for 10 minutes	SH	128.00	122.40	125.20
	CD	8.47	6.38	7.42
	NL	24.33	20.50	22.42
	FSW	135.89	145.53	140.71
	DSW	44.80	40.75	42.76
Soaking drupes in conc. H_2SO_4 for 15 minutes	SH	164.53	100.40	132.47
	CD	16.33	6.36	11.34
	NL	33.10	15.80	24.45
	FSW	250.01	145.07	197.54
	DSW	58.50	33.37	45.94
Mechanical scarification	SH	239.43	86.93	163.18
	CD	20.90	5.01	12.96
	NL	35.37	14.07	24.72
	FSW	345.00	114.33	229.66
	DSW	113.86	37.73	75.80
Cowdung	SH	23.17	54.67	38.92
	CD	9.83	4.60	7.22
	NL	27.67	13.07	20.37
	FSW	168.17	110.92	139.55
	DSW	42.20	26.64	34.42
Control- no treatment	SH	24.33	85.57	54.95
	CD	7.17	3.79	5.47
	NL	17.67	13.10	15.38
	FSW	167.26	88.45	127.85
	DSW	43.49	20.35	31.92
Mean	SH	101.21	101.34	
	CD	11.24	5.87	
	NL	26.67	16.76	
	FSW	191.27	129.49	
	DSW	53.50	33.70	

Effect	Parameter	CD (p=0.05)	±SE(m)
Treatments	SH	4.50	15.55
	CD	2.42	0.84
	NL	3.08	1.06
	FSW	16.69	5.76
	DSW	1.27	0.23
Sowing date	SH	N.S	8.31
	CD	1.30	0.44
	NL	1.64	0.57
	FSW	8.92	3.07
	DSW	0.67	0.43
Treatments x Sowing date	SH	63.75	22.00
	CD	3.42	1.18
	NL	4.36	1.50
	FSW	23.60	8.14
	DSW	1.79	0.62

SH-Seedling height (cm), CD-Collar diameter (mm), NL- Number of leaves, FSW-Fresh shoot weight (g), DSW-Dry shoot weight (g)

Table 3. Effect of pre-sowing treatment and sowing date on below ground parameters

Treatment	Parameter	Sowing date		Mean
		20th April	4th May	
Soaking drupes in GA_3 50 ppm for 24 hrs	LPR	20.20	11.40	15.80
	NSR	6.66	16.67	11.67
	FRW	55.65	45.80	50.75
	DRW	11.65	11.45	11.55
Soaking of drupes in GA_3 100 ppm for 24 hrs	LPR	26.13	22.13	24.13
	NSR	16.66	13.67	15.67
	FRW	59.45	42.32	50.88
	DRW	15.82	11.43	13.63
Soaking of drupes in conc. H_2SO_4 for 10 minutes	LPR	10.43	12.73	11.58
	NSR	13.00	10.00	11.50
	FRW	55.38	40.19	47.79
	DRW	11.60	14.10	12.85
Soaking drupes in H_2SO_4 for 15 minutes	LPR	30.23	11.20	20.72
	NSR	13.66	5.67	9.67
	FRW	100.30	37.18	68.74
	DRW	20.00	16.26	18.13
Mechanical scarification	LPR	30.20	22.13	26.17
	NSR	26.00	15.60	20.80
	FRW	131.50	29.23	80.37
	DRW	35.20	10.18	22.70
Cowdung	LPR	10.00	10.00	10.00
	NSR	18.00	4.00	11.00
	FRW	69.30	28.76	49.30
	DRW	16.68	10.35	15.52
Control- no treatment	LPR	10.00	4.70	7.35
	NSR	10.00	7.33	8.67
	FRW	52.45	25.09	38.77
	DRW	11.54	9.28	10.41
Mean	LPR	19.60	13.47	
	NSR	13.71	9.95	
	FRW	74.86	35.51	
	DRW	17.50	11.86	
Effect			$CD_{0.05}$	□SE(m)
Treatments	LPR		0.23	0.79
	NSR		1.41	0.48
	FRW		2.05	0.70
	DRW		1.54	0.53
Sowing date	LPR		0.12	0.04
	NSR		0.75	0.26
	FRW		1.11	0.37
	DRW		0.82	0.28
Treatment x Sowing date	LPR		0.33	0.11
	NSR		2.00	0.69
	FRW		2.90	1.00
	DRW		2.17	0.74

LPR- Length of primary root (cm), NSR-Number of secondary roots, FRW-Fresh root weight (g), DRW-Dry root weight (g)

Table 4. Effect of pre-sowing treatment and sowing date on whole seedling parameters

Treatment	Parameter	Sowing date		Mean
		20th April	4th May	
Soaking drupes in GA_3 50 ppm for 24 hrs	TSFW	184.08	196.57	190.33
	TSDW	49.15	50.65	49.90
	R:S ratio	0.31	0.29	0.30
	SQ	5.90	17.60	11.75
	SQI	8.62	2.28	5.58
Soaking of drupes in GA_3 100 ppm for 24 hrs	TSFW	204.18	193.70	198.94
	TSDW	49.98	49.28	49.63
	R:S ratio	0.46	0.29	0.37
	SQ	9.93	17.90	13.91
	SQI	4.41	2.36	3.25
Soaking of drupes in conc. H_2SO_4 for 10 minutes	TSFW	191.27	185.72	188.50
	TSDW	56.40	54.85	55.63
	R:S ratio	0.26	0.35	0.31
	SQ	16.39	19.51	17.95
	SQI	2.97	0.49	1.73
Soaking drupes in H_2SO_4 for 15 minutes	TSFW	125.31	182.25	153.78
	TSDW	78.50	49.63	64.07
	R:S ratio	0.30	0.45	0.37
	SQ	10.03	16.35	13.19
	SQI	6.03	2.78	4.40
Mechanical scarification	TSFW	476.50	143.56	310.03
	TSDW	149.06	47.91	98.49
	R:S ratio	0.32	0.33	0.33
	SQ	11.82	17.51	14.66
	SQI	12.07	2.56	7.32
Cowdung	TSFW	237.47	139.68	188.56
	TSDW	58.88	36.99	47.94
	R:S ratio	0.36	0.38	0.37
	SQ	2.37	11.98	7.18
	SQI	10.15	2.27	6.21
Control- no treatment	TSFW	219.71	113.54	166.63
	TSDW	60.81	29.60	45.21
	R:S ratio	0.27	0.45	0.36
	SQ	3.39	23.20	13.29
	SQI	0.95	1.19	1.07
Mean	TSFW	234.07	165.00	
	TSDW	71.83	45.56	
	R:S ratio	0.33	0.36	
	SQ	8.55	17.72	
	SQI	6.46	1.20	
Effect			CD (p=0.05)	±SE(m)

Cont...

Table 4. Effect of pre-sowing treatment and sowing date on whole seedling parameters

Treatment	Parameter	Sowing date		Mean
		20^{th} April	4^{th} May	
Treatments	TSFW		20.46	7.05
	TSDW		1.87	0.64
	R:S ratio		0.04	0.01
	SQ		5.08	1.75
	SQI		1.60	0.55
Sowing date	TSFW		9.98	3.80
	TSDW		1.00	0.34
	R:S ratio		0.02	0.01
	SQ		2.72	0.94
	SQI		0.85	0.29
Treatment x Sowing date	TSFW		29.66	10.23
	TSDW		2.65	0.91
	R:S ratio		0.06	0.02
	SQ		N.S	2.48
	SQI		2.27	0.78

TSFW-Total seedling fresh weight (g), TSDW-Total seedling dry weight (g), R:S- Root: shoot ratio, SQ-Sturdiness quotient, SQI- Seedling quality index

in enhancing fresh shoot weight, dry shoot weight, length of primary root, number of secondary roots, fresh root weight, dry root weight, total seedling fresh weight and total seedling dry weight. The maximum biomass parameters in mechanically scarified drupes in the current study might be due to early initiation of germination on account of faster absorption of water and gaseous exchange and consequently longer period of time for growth compared to remaining treatments. According to Jaenicke (1999) a small sturdiness quotient indicates a sturdy plant with higher expected chances of survival especially on windy or dry sites. Usually sturdiness quotient of less than six is desirable. In current study none of treatments had sturdiness quotient less than 6. The maximum root: shoot (0.37) was recorded in soaking of drupes in GA_3 100 ppm for 24 hours and was at par with soaking drupes in H_2SO_4 for 15 minutes, cowdung and mechanical scarification. Root:shoot ratio reflects the capacity of the roots to support the above ground biomass not only for anchorage but also in absorbing nutrients and water from the soil. A high root: shoot ratio indicates high absorption and storage capacity of water, which is an advantage, especially in conditions of limited soil moisture (Takoutsing et al 2016). In current study, all these treatments *i.e.* soaking of drupes in GA_3 100 ppm for 24 hours and soaking drupes in H_2SO_4 for 15 minutes, cowdung and mechanical scarification were equally good with respect to root:shoot ratio. The seedling quality index was highest in mechanical scarification in current study. Seedling quality index is overall indicator of seedling performance (Annapurna et al 2004). Since the majority of growth parameters were maximum in mechanical scarification, thereby, the seedling quality index was also highest in this treatment. This implies that overall the mechanical scarification is overall superior treatment.

CONCLUSION

The mechanical scarification of drupes of *Melia composita* needs to be carried out before sowing to enhance it's germination and growth. Sowing of the seeds in the month of April is appropriate than further delay.

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